UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY

FOREST INSECT INVESTIGATIONS

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REPORT ON INSECT CONDITIONS

HAPPY CAMP--LAVA BED AREA

MODOC NATIONAL FOREST, CALIFORNIA

Ninth Annual Report

October, 1930

by

HUBERT L. PERSON
Assistant Entomologist
U. S. Bureau of Entomology

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Table of Contents

	Page
Introduction	1
General Insect Conditions	1
Change in Type of Infestation	2
Insect Losses by Units	4
Glass Mountain Unit	4
Timber Mountain Unit	5
Dodger Unit	6
Lava Bed Unit	8
Happy Camp Unit	8
Pit River Unit	9
White Horse Unit	10
Conclusions	11
Table 1	12
Figures 1, 2, 3, 4	

INSECT CONDITIONS
HAPPY CAMP-LAVA BED AREA
MODOC NATIONAL FOREST

Introduction

The ninth annual survey of the Happy Camp-Lava Bed Area was made between August 12 and September 16, 1930. Because of the transfer of F.P. Keen, who has conducted all the former surveys of this area, and because of the relatively low stage of the infestation, the work was handled in a slightly different manner. Only nine of the check areas were cruised, and no strips were run except in a few cases, where they were used to locate trees for experimental purposes. As the entire field season was spent in the area on experimental work, the applicability of the figures from the check plots to the units as a whole was determined by general observation. In the Badger and Timber Mountain Units additional areas were cruised in connection with the biological control studies.

The entire survey was handled by the Bureau of Entomology at no expense to the Forest Service or the Pickering Lumber Company, who have been contributing to this survey for the past few years. Most of the check areas were cruised by Wagner, Bacon and the writer, with some assistance from Salman and Furniss, all of the Bureau of Entomology. The work was carried out as a part of the general program of investigative and survey work planned for the Modoc region. A temporary camp was established at Hackamore as a base for this work.

General Insect Conditions

The history of the past infestation on the area has been well covered by F.P. Keen[1] in a series of annual reports, and so will not be discussed in any detail in this report. The general trend of the infestation from 1921 to 1930 (Note 1) is shown graphically in Figure 1, which gives the estimated yearly loss for the area as a whole. This shows a rapid increase in the infestation, beginning in 1924 and reaching a peak in 1927. Since 1927 the infestation has declined on the area as a whole, although, as will be shown later, the 1930 loss on the Badger Unit is slightly greater than the 1929 loss. All other units, however, show a steady decline, beginning in 1928 and continuing through the summer of 1930. The volume losses by generations for the past three years are shown in Figure 2. It is believed that on most of the units the loss is down to a normal or endemic stage, and that any change is as likely to be in the direction of an increase as toward any further decrease. The course that is taken depends on a number of complex meteorological and biotic factors, such as precipitation and temperatures during the growing season of the tree and the flight and brood

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[1] Keen, F.P. Western Pine Beetle Survey, Happy Camp-Lava Bed Area, Modoc Nat. Forest, Calif., December 1930; unpublished report.

Note 1. As only a part of the 1930 winter loss is found at the time the survey was made, the 1930 loss is estimated, the amount found early in September being considered as approximately 70 per cent of the total.

development periods of the beetles and the abundance of natural enemies of the tree-killing insects. Because of the lack of any evidence of grouping in the 1930 winter-generation trees and the weakness of the western pine beetle infestation, as shown by the high percentage of the 1930-killed trees in which this beetle is either absent or secondary, the writer believes that there is no immediate danger of a very decided increase, at least for another year.

The estimated losses for 1930, as well as the acreage and stand for each of the units, are given in Table 1. Figure 4 shows the boundaries of the units and the location of the check plots.

Change in Type of Infestation in the Modoc Area

It may be noted that the title of this report differs from that of previous reports in that "Insect Conditions" has been substituted for "Western Pine Beetle Survey". The reason for this is that a very appreciable percentage of the trees killed in 1929, and particularly in 1930, were not killed by the western pine beetle. This is illustrated by Figure 5, which shows the percentage of the total loss caused by D.brevicomis for the years 1928, 1929 and 1930 in five of the units. The figures given are based on the data from the check areas only, and so are not necessarily representative of the entire unit. However, they are probably typical of the units which they represent except in the case of the Glass Mountain Unit, where the check area is located in the border type and so is more nearly representative of the Timber Mountain Unit than of the unit in which it is located. The Lava Bed and Timber Mountain Units were not included because they do not have comparable check areas.

The following table gives the data illustrated in Fig. 5, with a summary to show the average percentage of the total loss caused by the western pine beetle for the check areas of all the units:

Percentage of Insect Loss Caused by the Western Pine Beetle
(Volume Basis)

Location of Check Areas	Year of Attack		
	1928	1929	1930
Badger Unit	98.78	91.55	70.18
White Horse	98.82	81.07	71.61
Happy Camp	99.88	87.61	83.86
Pit River	95.64	77.66	85.65
Glass Mountain	85.34	89.75	51.18
Average for all check areas	95.70	81.57	72.50

This table shows a decided decrease in the relative importance of D.brevicomis from 1928 to 1930, with 95.70% of the trees killed by this beetle in 1928 and only 72.50% in 1930. The other trees were infested by Melanophila spp, Ips emarginatus, D.monticolae, D. valens and a few species of minor importance. The Buprestid and the

engraver beetle were the most abundant, though in many cases D.monticolae apparently made the initial attack. In many of the trees there was a mixture of broods including D.brevicomis, but even the present D.brevicomis was not considered primary unless it was evident from the stage of the broods that this species had made the first major attack.

Since the decline in relative importance of D.brevicomis parallels the decline of the epidemic, there is undoubtedly a close relation between the two. It is evident that although there has been a remarkable decline in the number of insect-killed trees since 1928, the decline in the D.brevicomis population is even greater. Apparently the population of the so-called secondary associates of D.brevicomis was greatly increased during the western pine beetle epidemic, but the factors that brought about the reduction in the abundance of D.brevicomis did not act so directly on its associates, with the result that, temporarily at least, the secondaries become of much greater relative importance than under normal conditions.

It is believed that the major factors in the decline in the western pine beetle epidemic were probably the enormous increase in the abundance of the natural enemies of this beetle, particularly insect predators, and the temporary increase in vigor of the trees, as shown by an increased growth rate in 1929. Since neither of these factors would affect the associates as directly as the western pine beetle, it is natural that the return of these associates to their normal importance would proceed more slowly than in the case of D.brevicomis. During the period of this lag we should expect to find the importance of these species greatly increased, as is the case in 1930. It is probable that the relative abundance of D.brevicomis and its associates will return to normal within the next year or two, either as the result of a decrease in the abundance of the associates or as the result of an increase in the abundance of D.brevicomis. Which it will be depends, as already noted, on a number of factors which are apparently unpredictable.

The importance of the associates is particularly noticeable on the poor border sites, such as are found on the Timber Mountain and parts of the Glass Mountain Unit, where nearly half of the trees killed in 1930 were killed by insects other than D.brevicomis. This much greater proportion of associates on these poor border sites, particularly the Buprestids, and the continued fairly heavy losses are difficult to explain in the face of a general decline in the infestation. If there is such an abundance of weakened trees, why should the D.brevicomis infestation decline? Apparently some factor, such as abundance of natural enemies, is strong enough to bring about a decline of the western pine beetle infestation even though there is an abundance of susceptible trees, or else the trees on these poorest sites are so badly weakened by drought that they have ceased to be attractive to the western pine beetle. This suggests the possibility that a tree may be too badly dried out to be attractive to the western pine beetle. This possibility is supported by the work of Beal[1], who found that the trees with the driest inner bark were apparently not so attractive to D.brevicomis as trees with moderately dry inner bark. In any case it seems

[1]Beal, J.A. "Phloem Moisture and Beetle Susceptibility of Western Yellow Pine" December 1929; unpublished report.

very probable that most of the trees on these driest border sites are doomed, irrespective of the abundance of insects on the area, unless there is a decided improvement in moisture conditions on these sites.

Insect Losses by Units

Glass Mountain Unit

The insect loss on this unit has returned to a normal, endemic stage, with 1930 losses well below one per cent of the stand for all the unit except a strip of border type one to two miles in width, extending from the middle of the east side of the unit around the north end to Caldwell Butte. In spite of the high percentage of the stand which has already been killed in this part of the unit during the past several years, the infestation may still be considered epidemic. The north half of Sec. 36, which has been cruised as a check area for a number of years, is representative of this border type, though not the most heavily infested part of it. The losses on this check area for the past three years are given in the following table:

Year	Total Stand Board Feet	Insect Loss No.Trees	Vol.Bd.Ft.	% of Stand(Vol.)
1928	3,500,000	439	266,130	7.60
1929		131	150,980	4.32
1930		156	84,545	2.41

The cause of this continued loss is evidently the accumulated moisture deficiency, which has reduced the soil moisture below the minimum required by western yellow pine. This is resulting in a recession of the yellow pine type, which is being converted to the juniper-sagebrush type which it borders. We find support for this belief in the fact that the loss continues even though the stand has already been heavily thinned and even though the western pine beetle population on the area is probably down to an endemic status. It seems evident that many of the trees are not being killed by insects, but are dying from purely physiological causes associated with a lack of sufficient moisture.

With the exception of this narrow border strip which has just been discussed, the unit is in good condition from the standpoint of insect loss and there is little prospect of any dangerous increases within the next year. The losses for 1930 on that part of the unit not included in the border strip would probably not exceed .50 of one per cent, but averaging the unit as a whole the 1930 loss is somewhat higher. The losses for the three-year period are as follows

Estimate of Losses, Glass Mountain Unit

Year	No. Trees	Volume Killed (M B.M.)	Per Cent of Stand Killed
1928	27,800	19,500	1.61
1929	17,000	17,000	1.46
1930	12,700	9,900	.82

Note: The losses for 1928 and 1929 are from Keen's report of December 1929. The 1930 loss is estimated from the 1930 cruise on the basis of 70% of the loss being spotted early in September.

Timber Mountain Unit

About 70 per cent of this entire unit was cruised in connection with our investigative studies in the latter part of June, and part of the unit was again cruised about the first of August. As a result of these cruises and the examination of a large number of infested trees which were felled, we have a fairly accurate picture of insect conditions on this unit for the winter generation of 1929 and the summer generation of 1930.

Conditions on much of this area are similar to the conditions found on the border type of the Glass Mountain Unit. Although the infestation has declined greatly since the peak of 1927 and apparently continues to decline, the annual loss is still quite high as compared with the endemic conditions on the other units. The loss continues not because of an aggressive western pine beetle infestation but in spite of a lack of it; and we are convinced that, as is the case in the border type of the Glass Mountain Unit, the death of many of the trees is more physiological than entomological.

Both the timbered acreage and the volume of timber on this unit have been so greatly reduced by fire and insects since 1925, when the acreage and stand figures used in previous reports were compiled, that these figures are no longer even approximately correct. The error resulting from using the original stand figure year after year as a basis for determining the annual insect loss in per cent of total stand has been carried through all the reports on the Modoc area, and on most of the units is probably well within the general accuracy of these reports. But on the Timber Mountain Unit, where the stand is only about half as great in 1930 as it was in 1925, this error would obviously be very great. Consequently it was thought best to revise the stand and acreage figures for this unit for subsequent use.

As this unit was considered as an area suitable for a biological control experiment, it was mapped by types, and the insect loss for the winter of 1929 and the summer of 1930 was marked on approximately 70 per cent of the area. On the basis of this cruise the timbered area, including both the normal and the lightly-stocked yellow pine stands, was found to include approximately 1600 acres. On the basis of stand figures from a sample plot of 40 acres and a general examination of the entire unit, it is believed that the average stand on the 1600 acres could not be over 7,000 board feet per acre. This would give a total stand for the unit of roughly 11,000 M.B.M.

Using these revised figures as a basis, the insect loss for 1928, 1929 and 1930 is about as follows:

Estimate of Losses, Timber Mountain Unit

Year	Total Stand M.B.M.	Insect Losses No. of Trees	Volume M.B.M.	% of Stand
1928	11,000		450	4.10
1929	"		400	3.64
1930	"	240	210	1.91

Note: The volume loss for 1928 and 1929 was taken from Keen's report and is believed to be a little low, as the 1929 winter loss alone was about 250 trees, with a volume of approximately 240 M.B.M.

Badger Unit

The control work recommended by Keen in his 1929 report for the Badger Unit was carried out by the Pickering Lumber Company, as suggested in November and December, 1929. The area covered included Sections 23,24,25,26 and 36, T 44 N, R 8 E; Secs. 19,30,31, T 44 N, R 9E; Sec. 1, T 43 N, R 8 E; and Sec. 6, T 43 N, R 9 E, in the general vicinity of Flag Spring. No detailed study was made to determine the effectiveness of this control work; but in a general examination of parts of the treated area it was noted that the work had been very well done, and that it had apparently reduced the infestation in the centers treated to the level of the infestation in the remainder of the unit.

In spite of the control work of 1928 and 1929 in the Badger area, this unit showed a slightly greater loss in 1930 than in 1929. While the increase is not large enought to be significant in itself, it is remarkable in comparison with the other units, on all of which the 1930 loss is only about 50 per cent of the 1929 loss. This absence of a decline on the Badger Unit may be due to a difference in the infestation cycle on this area as compared to the other units, or it may be due to the fact that the 1928 control work resulted in a 1929 loss which was lower than would have occurred normally, but which was not maintained in 1930 because of the small amount of work done in 1929.

Losses on the four check areas, which are cruised annually as representative of the Badger Unit, for 1929 and 1930 are as follows:

Losses on Check Areas of Badger Unit for 1929 and 1930

Check Area	Total Stand M.B.M.	1929 Losses No.Trs.	1929 Losses Volume M.B.M.	1929 Losses % of Tot.Vol.	1930 Losses No.Trs.	1930 Losses Volume M.B.M.	1930 Losses % of Tot.Vol.
T.44N.R.8E.							
S½ Sec. 13	-----	91	82	----	36	29	----
T.43N.R.7E							
" 22	4,100	45	41	1.00	24	45	1.10
T.43N.R8E							
W½ 10	3,900	24	26	.68	31	34	.87
T.44N.R.8E							
W½ 16	4,300	27	18	.42	24	26	.60

Note: The 1929 losses are taken from the 1929 cruise of Keen and the 1930 cruise by the writer. The 1930 losses are estimates on the basis of the 1930 cruise. The 1929 estimate of loss is somewhat lower, on the basis of the complete 1929 figures, than the estimate given by Keen on the basis of incomplete data from the 1929 cruise. Evidently the percentage of the total loss that was evident at the time the cruise was made in the fall of 1929 was greater than estimated.

The losses for the unit as a whole are as follows:

Estimate of Losses, Badger Unit

Year	No.Trees	Volume	Per Cent of Stand
1928		60,400	7.4
1929		6,140	.75
1930	8,200	6,960	.85

The losses found on this unit do not seem to justify any control work on the 1930 winter generation. As this entire unit was covered extensively during the summer of 1930, and additional plots, including the experimental marking plots, Brown's Sell sample plot and a half-section area in the vicinity of the Hackmore camp were also cruised, we have a good basis for determining the value of the check areas as representative of the unit as a whole. On this basis the writer believes that the average loss for the unit for 1930 is not over .85 per cent of the total stand, and that there is no concentration in any appreciable part of the area that would warrant the use of artificial control at the present time.

The heaviest remaining centers are south of Flag Springs and south and west of Deer Hill; but even in these areas the 1930 loss is little if any above one per cent of the total stand.

Lava Bed Unit

No check areas or strips were cruised in this unit in 1930, so we have no definite figures on the losses on this unit for 1930. However, on the basis of general observation from the roads through this unit as well as data from adjoining units, it is believed that the loss on this unit has continued to decline, and that the 1930 infestation is back to a normal, endemic stage, with an average loss of probably .50 per cent of the total stand.

Estimate of Losses, Lava Bed Unit

Year	Volume	Per Cent of Stand
1928	8,650	1.37
1929	5,280	.84
1930	3,140	.50

Happy Camp Unit

The losses on this unit have declined steadily since 1927 and are now down to about normal for the entire unit. The losses for 1929 and 1930 for the two check areas which were cruised on this unit are given in the following table:

Losses on Check Areas of the Happy Camp Unit

Check Area	Total Stand	1929 Losses			1930 Losses		
		No. Trs.	Volume: M.B.M.	% of Tot. Vol.	No. Trs.	Volume: M.B.M.	% of Tot. Vol.
T42N. R8E							
W½ Sec. 28	5,250	44	42	1.60	20	19	.37
T41N. R6E							
E½ " 18	No record	31	28		29	49	

As neither of the above check areas is included in the area outlined by Keen as suffering the heaviest loss, these figures--at least the ones for the W½ of Sec. 28--are probably a little below the average for the unit as a whole.

The estimates for the total losses on this unit for the years 1928, 1929 and 1930 are as follows:

Estimate of Losses, Happy Camp Unit

Year	No.Trees	Vol.Killed M.B.M.	% of Stand
1928	22,500	20,100	1.54
1929	9,400	8,930	.69
1930	7,500	7,130	.55

The 1928 and 1929 figures are taken from Keen's report, and the 1930 figures are estimates based on the 1930 survey.

Pit River Unit

The infestation in this unit is also down to the endemic stage, with no evidence of any immediate return to an epidemic status. The losses on the one check area which was cruised in this unit in 1930 are as follows:

Check Area	Total Stand M.B.M.	Insect Losses Year	No.Trs.	Volume	% of Tot.Stand
T. 41N. R 8E. N½ Sec. 24	3840	1928	53	42	1.08
		1929	48	47	1.23
		1930	37	19	.50

The apparent lack of a decline in volume in 1929 may be due to the difficulty of distinguishing 1929 overwintering trees from early summer trees of 1930 when the cruise was made in the fall of 1930. It is probable that there was actually a decrease in volume loss as well as in the number of trees killed.

The estimated loss for the unit as a whole for the past three years is as follows:

Estimate of Losses, Pit River Unit

Year	No.Trees	Volume M.B.M.	% of Tot.Stand
1928	8,800	7,000	2.29
1929	4,000	4,000	1.31
1930	3,200	2,400	.78

The 1928 and 1929 figures are taken from Keen's report; the 1930 figures are estimates on the basis of the 1930 survey.

White Horse Unit

As a result of improved growing conditions on this unit, which includes the best sites on the survey area, or the control work which has been done for several years by the McCloud Lumber Company, or both, the infestation on the unit is now lower than on any of the other units, and well below the annual increment.

The losses on the check area for the last three years are as follows:

Check Area	Total Stand M.B.M.	Year	Insect Losses No.Trs.	Volume M.B.M.	% of Tot.Stand
T.40N. R5E					
N½ Sec. 12	7,040	1928	87	171	2.42
		1929	31	48	.68
		1930	11	25	.36

The above figures are based on the combined surveys by Keen and the writer.

The losses on the unit as a whole are estimated as follows:

Estimate of Losses, White Horse Unit

Year	No.Trees	Volume M.B.M.	% of Tot.Stand
1928	14,900	17,900	1.34
1929	5,200	6,240	.49
1930	2,500	4,400	.34

Conclusions

On the basis of the recent survey made on the Happy Camp-Lava Bed area of the Modoc National Forest by the Bureau of Entomology during August and September, 1930, we may conclude that the infestation on this area has returned to a status close to the normal for this area. With the exception of a few small areas, particularly the dry border sites of the Timber Mountain and Glass Mountain Units, the loss for 1930 runs between .30 and 1.00 per cent of the total volume of the stand, with the average for the area approximately .61 per cent of the stand.

The 1930 loss of 33,740,000 feet b.m. is still about twiceas great as the loss for 1923, the lowest point in the infestation since the survey was begun in 1921 (see Fig. 1). But it is only slightly above the average for the five-year period, 1921-24, preceding the epidemic, and is probably close to the normal for the area when we consider the overmature nature of the stand and the low precipitation, especially during the last fifteen years. It seems probable that a definite, continuous improvement in the moisture supply, such as would result from a change to a wet cycle, would so increase the vigor of the stand that the loss from insects would be decreased to a point below that for any year for which we have a record.

Because there is no evidence of the building-up of dangerous centers, and because there are no areas of any considerable extent on which the 1930 losses amount to over 1.00 per cent of the stand (with the exception of the poor border sites where the timber is of no commercial value), no control work is recommended for the winter of 1930-31. The annual surveys in this area should be continued, however, because of the high susceptibility of the stand and the desirability of detecting any outbreaks in an early stage.

The trend of the infestation at the present time is difficult to predict. It is safe to assume that the infestation will either continue to decline or will start to increase again, because there is little possibility that it will remain static. The course taken depends on a number of complex factors, the action of which it is impossible to predict. However, because of the absence of any indication of group killing by the winter generation, and because on the basis of the action of known infestations we seldom find any very great increase in one year, the writer expects either a further decline or a moderate increase.

An interesting point in connection with the rapid decline of the epidemic is the relative increase in importance of the associates of D.brevicomis which are usually secondary in western yellow pine. The percentage of the total loss due to the western pine beetle decreased from 95.70 in 1928 to 72.50 in 1930. This is probably the result of an enormous increase in the population of these associates (Melanophila spp., Ips emarginatus, D.monticolae etc.) incidental to the increase in the western pine beetle infestation from 1923 to 1928, which associated population is decreasing much more slowly than the D.brevicomis population. This seems logical, since the factors which probably caused the decline in the western pine beetle infestation--particularly abundance of predators of D.brevicomis and the increased vigor of most of the trees in 1928--would not so directly affect the associates.

TABLE 1

Happy Camp-Lava Bed Area
Acreage, Stand and Insect Loss by Units
Estimate for 1930

Unit	Acres	Volume of Stand (M.B.M.)	Killed During 1930			
			Trees	Av. Volume per Tree	Volume M.B.M.	Per cent of Stand
Glass Mountain	68,860	1,162,000	12,700	750	9,500	.82
Timber Mountain	1,600	11,000	240	875	210	1.91
Badger	67,760	813,000	8,200	350	2,900	.35
Lava Bed	73,200	629,000	3,900	800	3,140	.50
Happy Camp	68,660	1,292,000	7,500	950	7,130	.55
Pit River	35,200	306,000	3,200	750	2,400	.78
White Horse	60,800	1,278,000	2,500	1,750	4,400	.34
Totals	376,080	5,496,000	38,240	880	33,740	.61

Fig. 1

Summary of Insect Losses
Happy Camp Lava Bed Area
Modoc National Forest

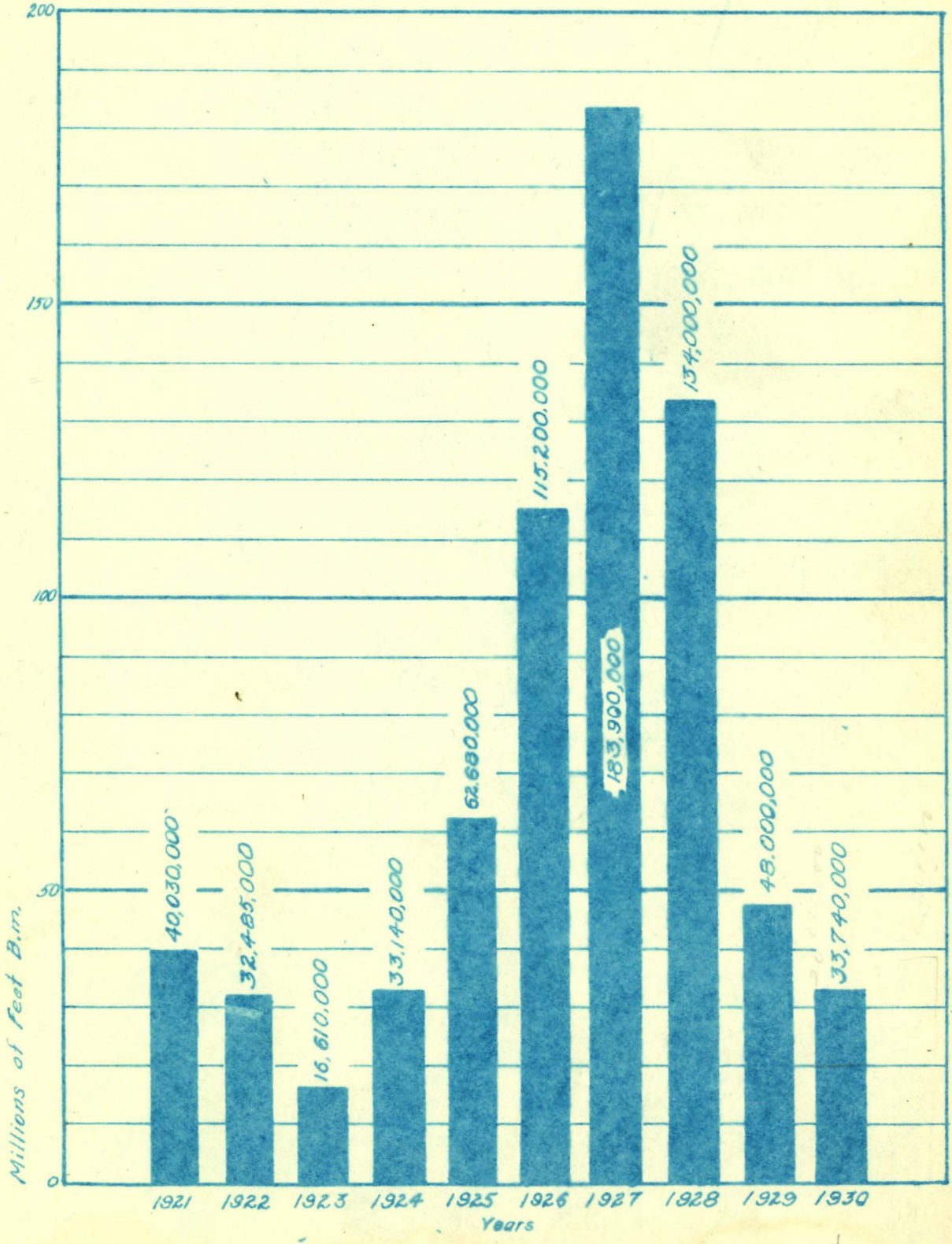

Fig 2

Summary of Insect Losses by Generations Happy Camp Lava Beds Survey Units

Modoc National Forest

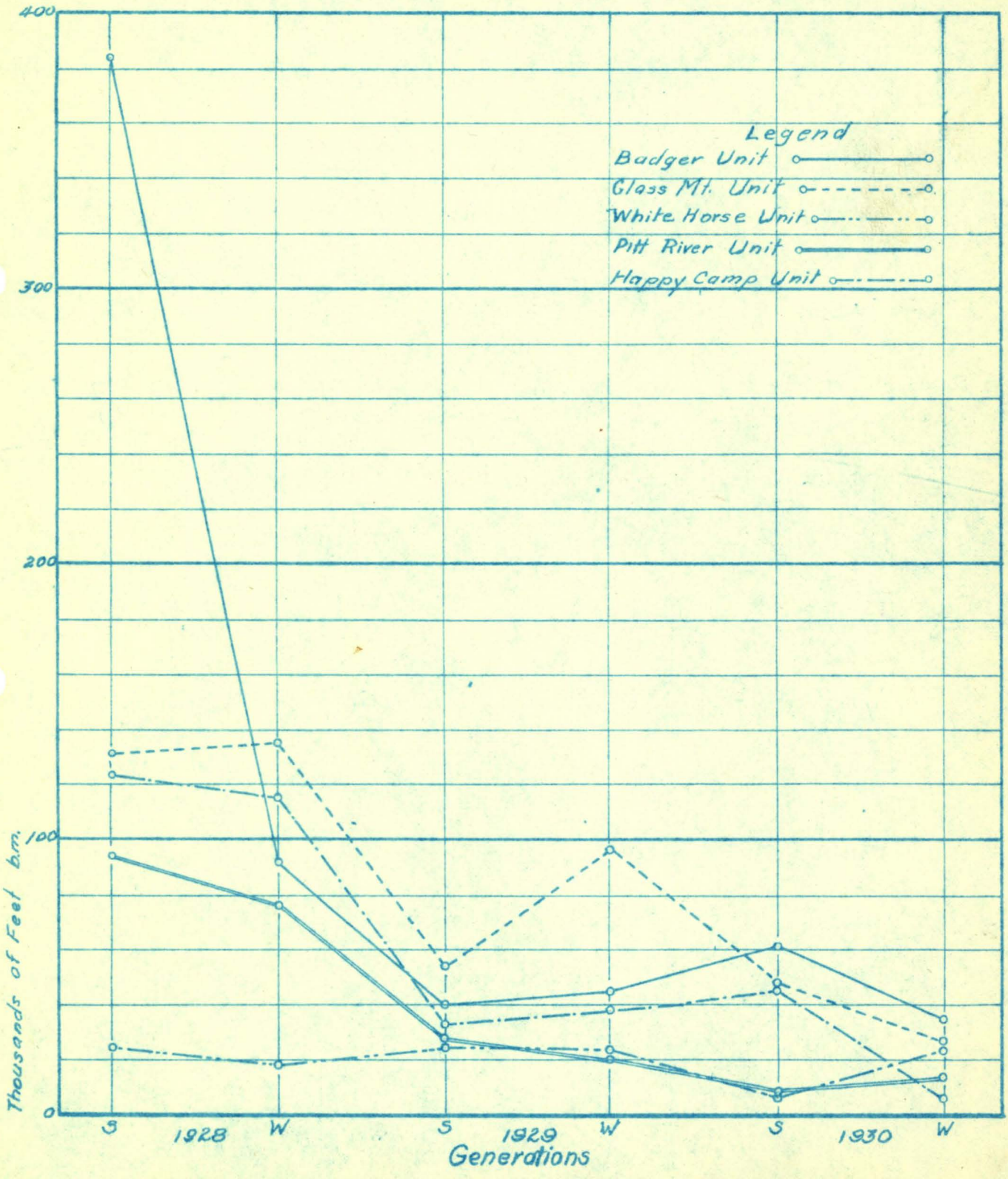

Fig. 3

Percent of Total Loss Due to D. brevicomis

Compared by Units

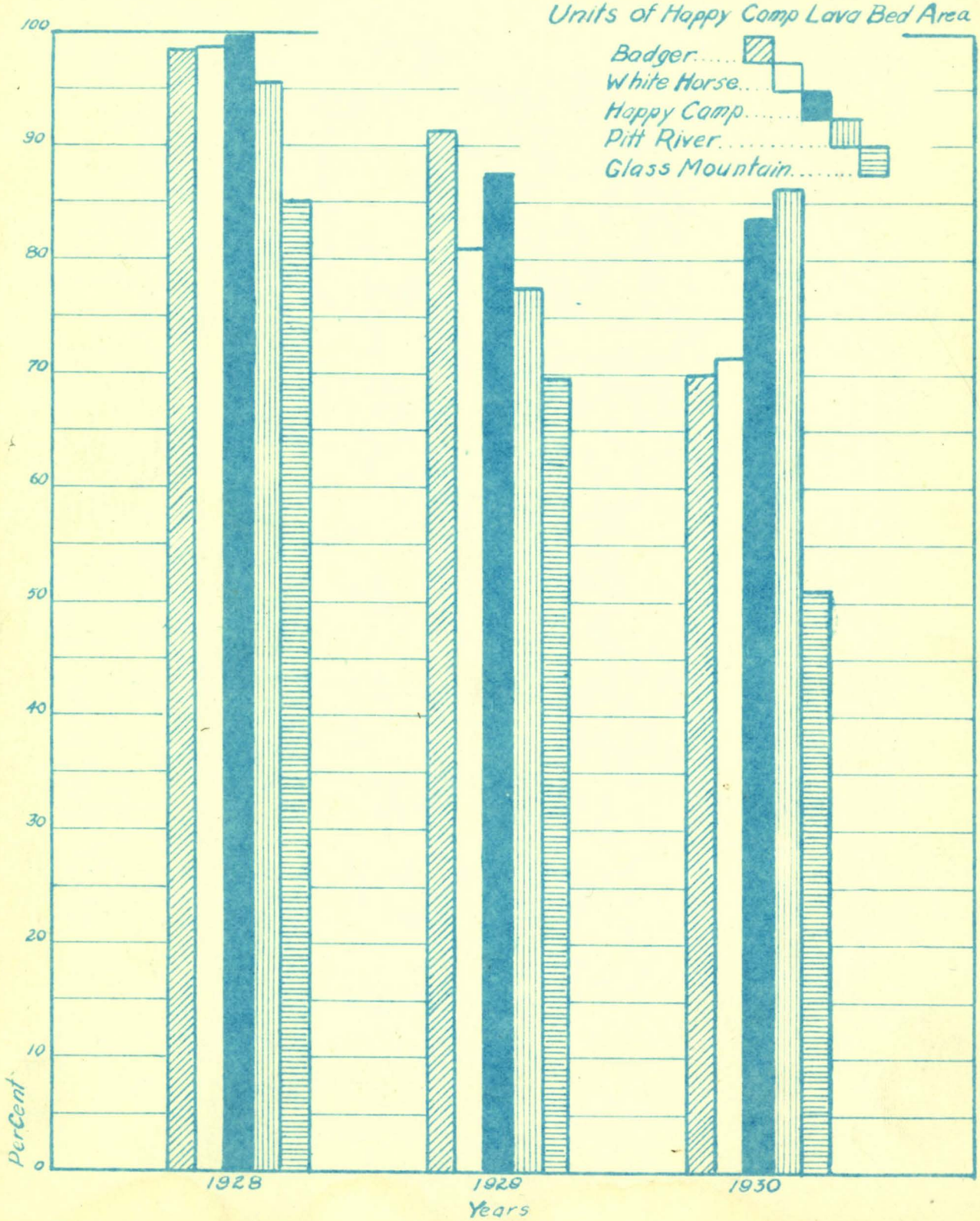

Fig. 4. Map of the Happy Camp--Lava Bed Area, showing the boundaries of the survey units and the location of the permanent check areas

NATIONAL MONUMENT
Schonchin Butte
R4E
R5E
R6E
R7E
R8E
R9E
T. 45 N.
T. 44 N.
T. 43 N.
T. 42 N.
T. 41 N.
T. 40 N.
T. 39 N.
40'
41° 30'
20'
Caldwell Butte
Big Sand Butte
East Sand Butte
Little Sand Butte
Mammoth Cave
Cougar Butte
Indian Butte
Mt. Hoffman
Timber Mt.
Glass Mt.
Red Shale Butte
GLASS MT UNIT
Black Mt.
Dry Lake Ranch
Cummins
Double Head
Dry Pond
Mowich Butte
Lone Pine Butte
STATE GAME REFUGE
No. 1 B
BADGER UNIT
Deer Hill
Widow Valley
Rail Mt.
Williams Reservoir
Duncan Reservoir
PIT RIVER UNIT
LAVA BED UNIT
GAME REFUGE
Buck Butte
Webb Butte
HAPPY CAMP UNIT
Happy Camp Lookout
PIT RIVER R.S.
HAPPY CAMP R.S.
Allen Place
Johnson
Schaffer Mt.
Standard
Rattlesnake Butte
Lorenz Gould
Mitchell
Andrews
DUTCH FLAT R.S.
Roberts Res.
Joiner
A. Criss
Lookout
Adin
WHITE HORSE UNIT
White Horse Flat
White Horse Res.
Taylor Horse Mt.
Cramer Res.
Little Hot Spring Valley
Day
Widow Valley
Clear Creek
Ash
Hole in Rock
Ice Cave
Water Holes
Indian Spg.
8th
Barnum Flat
Hamilton Spg.
Lava Lake
Mud Spg.
Crater
Round Mt.
Sugar Pine Ridge
Payne Spg.
Cabinhan Spr.
Badger Spg.
Corral
Potter Well
Duncan Horse Camp
Badger Well
Browns Well
Canyon Res.
Upper Mud Lake
Beeler Res.
Spring Creek
Hog L.
Grouse Spg.
Sherer
Rattlesnake Spr.
Lorenz Spg.
Roberts Lower Res.
Potters Sawmill
Timber Mt. Sawmill
Franklin Sawmill
TO MEDICINE LAKE
TO MC CLOUD
BURNT LAVA FLOW
SISKIYOU CO.
MODOC CO.
SISKIYOU CO. MODOC CO.
Benito L.
CHIMNEYS
ICE RIVER CAVE
SKULL CAVE
BEARFOOT CAVE
ICE CAVE
INDIAN WELL
CALDWELL CAVES
SHEPPE CAVE
CAVE
WATER
Water
Spg.
Res.
Mt.
L.
Creek
R.S.
Lookout